

Abstract:

Particle populations are widely used in many industrial applications and fields of science from physics to biology or agronomy. In chemical engineering, in particular, it is generally desired to extract information on geometrical characteristics and on spatial distribution from 2D images of the population of particles involved in the process. For example in pharmaceuticals, the size and the shape of crystals of active ingredients are known to have a considerable impact on the final quality of products, such as drugs. Hence, it is of main importance to be able to control in real time the granulometry (size and shape) of the crystals during the process. The first part of this talk will be focused on specific geometrical and morphometrical descriptors giving information on the size, shape and spatial distribution of the particles. They have a compact representation with good mathematical properties and are easy to compute. They are based on integral geometry, shape diagrams and computational geometry. The second part of this talk will show different ways (deterministic and stochastic methods) of image processing, analysis and modeling to geometrically characterize the particles from a sequence of 2-D images acquired by a camera (visualizing the particles during a particular process). The developed methods will be presented by addressing different issues: the perspective projection of the 3-D particle shape onto the image plane, the blurred appearance of unfocused particles, the degree of agglomeration or overlapping, and the random variation in size/shape of the observed particles. The methods are mainly based on image enhancement, restoration, segmentation, tracking, modeling, feature detection, stereology, stochastic geometry, pattern analysis and recognition. The methods will be particularly illustrated on real applications of crystallization processes (for pharmaceuticals industry) and multiphase flow processes (for nuclear industry). Some conclusions and prospects will be finally given.

Short Biography:

Johan Debayle received his M.Sc., Ph.D. and Habilitation degrees in the field of image processing and analysis, in 2002, 2005 and 2012 respectively. Currently, he is a Full Professor at the Ecole Nationale Supérieure des Mines de Saint-Etienne (ENSM-SE) in France, within the SPIN Center and the LGF Laboratory, UMR CNRS 5307, where he leads the PMDM Department interested in image analysis of granular media. In 2015, he was a Visiting Researcher for 3 months at the ITWM Fraunhofer / University of Kaiserslautern in Germany. In 2017, he was invited as Guest Lecturer at the University Gadjah Mada, Yogyakarta, Indonesia. He was also Invited Professor at the University of Puebla in Mexico in 2018. He is the Head of the Master of Science in Mathematical Imaging and Spatial Pattern Analysis (MISPA) at the ENSM-SE. His research interests include image processing and analysis, pattern recognition and stochastic geometry. He published more than 120 international papers in international journals and conference proceedings and served as Program committee member in several international conferences (IEEE ICIP, MICCAI, ICIAR...). He is Associate Editor for 3 international journals: Pattern Analysis and Applications (Springer), Journal of Electronic Imaging (SPIE) and Image Analysis and Stereology (ISSIA). He is a member of the the International Association for Pattern Recognition (IAPR), International Society for Stereology and Image Analysis (ISSIA) and Senior Member of the Institute of Electrical and Electronics Engineers (IEEE). He is also Officer (Membership Development) of the IEEE France Section.